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WATER FOR THE FUTURE

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WATER FOR THE FUTURE

WATER, natural resource that is basic to life itself, is becoming a more and more precious commodity in the United States. Assurance of adequate supplies for the present and the future is a pressing problem for government officials, industry executives, planners, and plain citizens. Water supplies remain fairly constant — as a result of nature's replenishment — but water requirements are rising sharply. Growth of population and expansion of industry make it imperative that the usable supply be increased.

The report of a Cabinet Committee on Water Resources Policy, intended to provide the background for presidential recommendations on water legislation, is currently awaited at the White House. President Eisenhower, in his State of the Union message last Jan. 6, noted "great need" for a "nation-wide comprehensive water resources policy" and said that such a policy, then already in preparation, would be proposed to Congress. The President had set up the Cabinet committee in May 1954 and at the same time established an inter-agency committee to coordinate federal water activities and assist the Cabinet group.[1]

The Hoover Commission scheduled a study of water resources and power as soon as it was constituted in September 1953. The report, released as the commission went out of existence on June 30, 1955, recommended that Congress adopt a national water policy and that the Cabinet and inter-agency committees be "transformed into a Water Resources Board to be located in the Executive Office of the President." To consist of Cabinet and public members, the proposed board would "determine . . . broad policies" and "devise methods of coordination of plans and actions" of federal agencies dealing with water problems at Washington and in the field.

[1] The Cabinet committee consists of Interior Secretary McKay, chairman; the Secretaries of Agriculture, Commerce, Defense, and Health, Education and Welfare; and the Director of the Budget Bureau. Eisenhower told the National Rivers and Harbors Congress, May 25, 1954, that the Cabinet and inter-agency committees would "work . . . to make certain that we won't wake up two decades from now and regret that we didn't act intelligently back in 1954."

QUANTITY AND QUALITY OF U. S. WATER SUPPLY

Competent water authorities estimate that total available U.S. water resources, as replenished by precipitation, will exceed the foreseeable total demand for at least a century; the experts explain, however, that such an estimate is largely meaningless. Assurance of sufficient water supplies involves considerations not only of resources but also of time, geography, and use. The problem is mainly one of having enough water of the right quality in the right place at the right time. C. G. Paulsen, chief hydraulic engineer of the U.S. Geological Survey, has said that if a single word were used to sum up America's water problems, it would be "maldistribution." "We have a generous supply of fresh water," according to Paulsen, "but it is so unevenly distributed . . . more than ample in some places and insufficient in others." [2]

The supply of water in any particular place consists of that found in streams, lakes, and natural underground reservoirs, plus what may be brought from afar by canals and pipelines. Some water evaporates, some is used up by vegetation, and some passes into the ground. The remainder — the run-off — is discharged into surface streams and flows into the ocean. Of the 30 inches of average annual precipitation in the United States, about 8.5 inches, or 1.2 trillion gallons a day, is run-off.

Using long-term average run-off as an index, Paulsen has calculated the annual available water supply at about 1,300 million acre-feet, as compared with an annual withdrawal use of only about 195 million acre-feet.[3] Average annual run-off amounts to about 15 inches in the East, South, and Middle West but to only about 4.5 inches in the remaining western states. Even in the West the total average annual supply is about 390 million acre-feet and withdrawal use about 100 million acre-feet. But in certain local areas the situation is critical. Comprising 60 per cent of the nation's land area, the western states have only around 30 per cent of its water supply. Generally, water is at a premium in regions where average annual run-off is less than one inch; nearly one-third of the area of the United States is in that category.

[2] Address before American Association for Advancement of Science, Berkeley, Cal., Dec. 27, 1954.

[3] An acre-foot of water is the amount required to cover one acre to a depth of one foot, or about 325,000 gallons. Withdrawal uses are those requiring removal of water from the ground or stream, as for irrigation, municipal, or industrial purposes; non-withdrawal uses, such as navigation, recreation, and waste disposal, are those not requiring diversion.

The volume of ground water — that which has seeped into the soil and is stored in natural reservoirs in the rocks beneath the water table — is many times greater than the volume of surface water. Ground-water reservoirs have been estimated to contain perhaps as much as 35 years' average run-off. But, like surface water, ground water is unevenly distributed over the country, and only a comparatively small amount is available for consumption. In recent years, however, ground water has been used increasingly.

Considerations of quality, as well as quantity, must be taken into account in calculating water supply. Although water may be plentiful in certain regions, high-grade water may be scarce. The East's major water problem is one of quality rather than quantity. Water, as it occurs in nature, is never quite pure, but industrial requirements with respect to chemical and physical characteristics are extremely exacting. Water for use in high-pressure boilers and in the processed foods, beverage, and synthetics industries must be of high grade, and nearly every technological advance calls for use of still purer water.

Stability of Country's Overall Water Supply

Numerous local water shortages in recent years have given rise to fears of a general diminution of the national water supply. David L. Lilienthal, formerly chairman of the Tennessee Valley Authority and the Atomic Energy Commission, warned a Chicago audience, Feb. 15, of a "threatened water supply crisis." But Paulsen told a water policy conference at Jefferson City, Mo., two months later, that a study of such river flow records as are available revealed no "significant trends in total potential water supply." Another Geological Survey official, S. K. Love, addressing a Pittsburgh water conference last October, said that "There is no such thing as an overall nation-wide depletion of ground water."

A recent Commerce Department survey of 552 major public water supply systems showed that 58 per cent had "adequate" facilities, 21 per cent had facilities of "uncertain adequacy," and 21 percent had "inadequate" facilities.[4] *Fortune* magazine last year published a survey of the water

[4] Walter L. Picton and Henry J. Sullivan (of the Water and Sewerage Industry and Utilities Division, Business and Defense Services Administration), *Adequacy of Our Public Water Supplies, 1953 Summary* (March 1955), pp. 3-4. Supply systems were considered "adequate" if they had a "combination capacity exceeding the maximum day by over 20 per cent."

needs of large companies in five big industries and concluded that "Over the next 25 years industry will not find all the water it wants everywhere in the U.S., but it should still find good supplies in most areas where expansion is logical." The magazine pointed out, however, that "Texas and Southern California may be important exceptions." [5]

ENORMOUS INCREASE IN WATER USE IN RECENT YEARS

According to admittedly rough estimates, daily withdrawal of water in the United States in 1954 may have exceeded 200 billion gallons. Comparable estimates for 1950, latest year for which the Geological Survey has published detailed statistics, gave a total of about 170 billion gallons a day,[6] exclusive of 1,100 billion gallons a day drawn from streams to generate power and then in large part returned to the streams.

ESTIMATED USE OF WATER IN UNITED STATES, 1950
(billion gallons daily)

Use	Surface water	Ground water	Total
Irrigation	61.0	18.0	79.0
Industrial	72.0	5.0	77.0
Municipal	10.0	4.0	14.0
Rural (excluding irrigation)	2.9	0.7	3.6
Total	145.9	27.7	173.6

SOURCE: K. A. MacKichan, *Estimated Use of Water in the United States—1950*, pp. 6-7, 13.

Growing dependence on water raised per capita consumption from 600 gallons a day in 1900 to around 1,100 gallons a day in 1950. Although the bulk of the total was used to meet other than domestic needs, per capita consumption from municipal water systems alone rose from around 100 gallons a day at the turn of the century to 145 gallons in 1950. In the same period the population approximately doubled.

With the population continuing to increase and standards of living continuing to rise, both total and per capita consumption of water will keep on mounting. As air conditioners, washing machines, dishwashers, and garbage disposers become more and more common, the demand for water goes

[5] Francis Bello, "How Are We Fixed for Water?" *Fortune*, March 1954, p. 120.

[6] "The estimate is very rough and probably represents only a general approximation of the quantity used." — K. A. MacKichan, *Estimated Use of Water in the United States — 1950* (Geological Survey Circular 115, May 1951), p. 13.

up.[7] Many modern household appliances, though not consumers of water themselves, are consumers of electricity; they thus indirectly bring about greatly increased use of water by hydroelectric and steam-electric power plants. It has been estimated that the steam-electric power and the steel industries, the two largest industrial users of water, required 50 billion gallons daily in 1950.

Industrial plants, dominant consumers of water in the East, require vast quantities — for cooling, washing, grading, moving, and flushing purposes. Present industrial consumption is probably 100 billion gallons a day. About 100,000 gallons of water is required in the manufacture of an automobile, 65,000 gallons in the making of a ton of steel, and 40,000 gallons in the production of a ton of wood pulp. Furthermore, industrial production as a whole, which showed a 700 per cent increase between 1900 and 1950,[8] is expected to double again by 1975. "The thirst of our industries has been intense," Arthur M. Piper of the Geological Survey has written. "With the recent . . . upsurge of chemical-synthesis processes, that thirst is becoming all but insatiable." [9]

As existing supplies of high-grade raw materials are exhausted, more extensive use is made of lower-grade materials and more water is needed to wash and otherwise prepare them. Manufacture of synthetic products, moreover, invariably requires much more water than processing of the natural materials they replace — for example, in the case of nylon as against natural fibers, and of synthetic rubber as against natural rubber.

Irrigation, next to power the country's greatest user of water, accounts for about one-half of all the water withdrawn and has shown the largest consumption increases in the past century. Twenty-six million acres were irrigated in 1950. Once confined mostly to the western states, irrigation in recent years has been introduced in the East to increase crop yields, and it is spreading in the South. It is expected that supplemental irrigation will be resorted to

[7] Some water experts have expressed concern about air conditioning as a contributor to water wastage. They point out that water is so cheap that it can be used in a "once-through" cooling system and then discharged into sewers. Many cities have required installation of water-saving devices for air-conditioning equipment, and both New Jersey and New York have imposed restrictions on wasteful use of water for air conditioning.

[8] As measured by the Federal Reserve Board's index of industrial production.

[9] Arthur M. Piper, "The Nation-Wide Water Shortage," in House Interior Committee, *The Physical and Economic Foundation of Natural Resources, Part IV: Subsurface Facilities of Water Management and Patterns — Type Area Studies* (1953), p. 1.

before long in other humid areas as well. More than three million acres are now under sprinkler irrigation; $55 million was spent in 1954 for sprinkler irrigation equipment, 22 per cent more than in the preceding year.[10] Water requirements for irrigation give rise for concern, not only because of the vast quantities involved, but also because so much of the water used is lost through evaporation and transpiration and therefore cannot be re-used, as it can in industry.

Withdrawals of water increased fourfold between 1900 and 1950 and, it is estimated, will double again between 1950 and 1975. The President's Materials Policy (Paley) Commission estimated in 1952 that 350 billion gallons daily might be required by 1975. A Geological Survey official has observed that "The use of water will undoubtedly continue to increase, possibly at an accelerated rate, so long as our economy continues to expand." [11]

Variety of Reasons for Numerous Local Shortages

The enormous increase in water use has been responsible for many shortages in recent years. Fairfield Osborn, president of the Conservation Foundation, has estimated that 40 million persons in the United States have inadequate water supplies. Shortages have been caused not only by expansion of population, industry, and irrigation, but also by failure of local water supply due to insufficient precipitation, exhaustion of surface storage, or withdrawal of water from underground reservoirs at rates in excess of natural recharge. Other causes have been failure to provide storage structures to hold seasonal surpluses for later distribution, selection of plant sites without adequate attention to local water supply, and wastage. Inadequacy of facilities for treatment or distribution is sometimes to blame; in normally humid areas the reason for so-called shortages frequently is not a natural scarcity of water but rather a deficiency in facilities for collection, storage, and distribution.

According to the latest Geological Survey inventory, about 1,100 of the 16,750 public water systems in the United States were forced in 1953 to restrict the use of water by some or all of their 24 million customers. Thirty-five of the 93 supply systems serving communities of more than 100,000 inhabi-

[10] Figures cited by Charles Curran, administrator of the Hoover Commission's task force on water resources, before Interstate Commission on the Potomac River Basin, Winchester, Va., May 12, 1955.

[11] Albert N. Sayre, chief, Ground Water Branch, U. S. Geological Survey, speaking before Association of Western State Engineers, Reno, Aug. 18, 1953.

tants were affected by shortages.[12] The Geological Survey concluded that the predominant reason for the shortages was "increase in population or seasonal use," but it noted that among the larger systems alone "the majority of the shortages were attributed to inadequate treatment and distribution facilities." [13]

Failure of supply or drought was responsible for only 367 of the approximately 1,100 shortages cited in the 1953 inventory. During the water year which ended Sept. 30, 1954, the southern two-thirds of the United States suffered serious drought, with the situation becoming critical in the Southeast at the end of the year. In May 1955, latest month for which such information is available, run-off and groundwater levels were considerably below normal in most of the United States.

Shortages sometimes occur even where water is plentiful, because the available supply is salty, unclean, or otherwise of poor quality. Contamination of water supplies produces a water shortage as effectively as a drought; pollution is responsible for much of the diminution of supply, especially in eastern industrial regions. It has been estimated that, of the 170 billion gallons of water withdrawn daily, 100 billion gallons finds its way back to streams and lakes but in so contaminated a state as to hamper its re-use. The U.S. Public Health Service has estimated that there are some 22,000 major sources of pollution in the country, one-half of which are municipal sewer outlets and one-half private industrial waste outlets. Mark D. Hollis, Assistant Surgeon General of the Public Health Service, has said that "The streams simply can no longer take the load of pollution we are putting on them." [14]

Paulsen has asserted that many water shortages are avoidable and could be prevented by more careful investigation and planning.

> Analysis of hundreds of public water shortages that have occurred during recent years indicates that most . . . were the result either of planning on the basis of inadequate data or [of] increasing water demands not accompanied by adequate expansion of facilities . . . Preventable shortages . . . often are mistakenly referred to as

[12] Idaho, Mississippi, and Rhode Island were the only states in which no shortages were reported.

[13] K. A. MacKichan and J. B. Graham, "Public Water Supply Shortages, 1953," *Water Resources Review, Supplement 2* (1954), pp. 1-2, 8.

[14] Discussion at Mid-Century Conference on Resources for the Future, Washington, D. C., Dec. 2-4, 1953. The conference, sponsored by Resources for the Future, Inc., was financed by the Ford Foundation. For detailed discussion of the pollution problem, see "Water Pollution," *E.R.R.*, Vol. II 1953, pp. 483-498.

drought shortages when more properly they should be described as . . . [the results of] inadequate planning.[15]

President Gilbert F. White of Haverford College, who was vice chairman of President Truman's Water Resources Policy Commission, has observed that "Most so-called shortages of water are shortages in human vision and efficiency." [16]

Attempts to Alleviate Water Shortages

MEASURES to combat water shortages must be based on consideration of the fact that water, unlike other resources, cannot be saved by non-use. It can be conserved, however, in the sense that the available supply, if used prudently, can be made to last longer and serve more needs. "The conservation of water is not so much the saving of a decreasing supply for some greater need in the future, as, for example, the storing of natural gas, but the control and use of water to the optimum advantage of all." [17]

Water experts point out that many corrective measures in water management and economies in use are possible. Usable supply can be increased by a great variety of means. Both quantitative and qualitative requirements can be modified. Existing supplies can be utilized more thoroughly by more efficient use and by re-use. Wastage can be reduced, and new sources of supply may be developed.

Better Management and Replenishment of Sources

Improved land management has been emphasized as one of the prime factors in enlarging water supplies. Because land and water are inseparably linked by nature, conservation of land resources aids conservation of water resources. "Everything depends on what happens to water after it lands on the ground," Tom Wallace, editor-emeritus of the *Louisville Times* and a noted conservationist, told the 1953 Mid-Century Conference on Resources for the Future. "Not enough interest is taken in what happens to the watersheds." Properly cultivated fields and lands increase water supplies

[15] C. G. Paulsen, address before water policy conference sponsored by Missouri Conservation Federation, Jefferson City, Mo., Apr. 15, 1955.

[16] Mid-Century Conference on Resources for the Future, *The Nation Looks at Its Resources* (1954), p. 175.

[17] C. G. Paulsen, paper presented at symposium on renewable natural resources, at Laval University, Quebec, Oct. 5, 1952.

by keeping soil from washing down into reservoirs and by checking run-off, so that precipitation is released to streams more gradually and more is absorbed to lift water levels.

It is important, however, that the ground should not be covered by non-beneficial vegetation. Phreatophytes, or water-loving plants — the best-known is salt cedar, a small, scrubby tree, which thrives along stream channels — not only use up a great deal of water but also concentrate minerals in the remaining supply. A Geological Survey engineer has estimated that phreatophytes cover about 15 million acres in 17 western states and consume 20-25 million acre-feet of water annually. Eradication of such vegetation might salvage a large percentage of this water.

Reduction of the volume of water lost by evaporation — millions of acre-feet annually — also would help to increase the available supply. Such loss can be held to a minimum by selecting reservoir sites with small surface areas in places where climatic conditions are least favorable for evaporation. It has been estimated that periodic thinning and harvesting of young trees would produce a 25 per cent increase in water yield. More efficient application of water for irrigation could bring about substantial savings. Cases have been reported in which drought-caused restrictions on the use of irrigation water actually resulted in considerable increases in both the quality and quantity of the crops produced. Lining irrigation ditches and preventing water loss at the end of irrigation runs also would save water.

Prevention of salt-water contamination of fresh-water supplies is important. Salt-water encroachment occurs when the water level in a ground-water reservoir is lowered to such an extent that salt water from deep-lying strata or from the sea flows in. Injudicious withdrawal of ground water has resulted in salt-water intrusion in Arizona, California, Florida, Louisiana, South Carolina, and Texas. Contamination can be reduced or prevented by introducing a fresh-water barrier between the salt and fresh water, by distributing wells more carefully, and by plugging abandoned wells. In Los Angeles County saline intrusion has been halted by filling a series of wells near the coast with treated sewage effluent.

Ground-water supplies can be replenished by artificial recharge — pumping surface water into the ground through specially prepared wells or by spreading water over the land.

The practice of injecting water from surface reservoirs into underground reservoirs has been followed in California, Iowa, New York, North Dakota, Texas, and other states. Underground supplies may be replenished also by the capture of flood waters, as has been done in the Los Angeles basin.

Re-Use of Water by Industry; Pollution Abatement

The President's Materials Policy Commission reported in 1952 that a survey of some 3,000 industrial plants indicated that more than one-half of them did not recirculate their water. Industry, however, has become increasingly aware of the need to re-use water. More and more companies have installed cooling towers and recirculating devices. The Kaiser Steel plant at Fontana, Cal., and the Humble Oil plant at Baytown, Tex., are frequently cited as examples of efficient re-use of available water supplies.

The Kaiser plant uses 18 cooling towers and a system of re-use in which each successive use requires water of lower quality than the preceding one. Consequently, the plant requires only 1,100 gallons in producing a ton of steel as contrasted with the industry-wide average of about 65,000 gallons. The Humble refinery, as a result of extensive recirculation, uses only 40 million gallons a day instead of 600 million — in effect, it recirculates its water 15 times. A steam-electric power plant recently built in Texas uses only one gallon of water per kilowatt-hour of output, as compared with 60-100 gallons required by power plants that do not recirculate their water.

Use of reclaimed sewage and other wastes is on the increase. An outstanding example is provided by the Sparrows Point plant of the Bethlehem Steel Co., near Baltimore. It uses 55-60 million gallons a day of treated Baltimore sewage and eventually may take the city's entire flow. This arrangement relieves Baltimore of a disposal problem that might require an outlay of $15 million for facilities; instead, the city is taking in about $38,000 a year from sale of the sewage. Other firms that use processed sewage include the Kaiser Steel plant at Fontana, Cal., the Cosden Oil refinery near Big Spring, Tex., and the Shell Oil plant near Ventura, Cal. Reclaimed sewage effluent is used also in agriculture.

Much good-quality water can be saved by using poor-quality water wherever possible. For example, a large

quantity of saline water is used for industrial cooling. A number of industries along the Gulf Coast and elsewhere utilize water from brackish streams in processes where high-grade water is not essential. Nearly 13 billion gallons of brackish water was withdrawn daily in 1950 by industrial plants in eight eastern states.

Usable supply can be increased by pollution abatement. Some progress is being made in pollution control, but "The rate of construction [of treatment facilities] is still far less than that required to bring under control the pollution caused by municipal wastes." [18] Treatment of industrial wastes also is gaining, but progress depends on installation of thousands of additional facilities. To help find solutions to industrial waste problems, a National Technical Task Committee, representing 36 major industrial groups, was formed in 1950 to cooperate with the U.S. Public Health Service in compiling and exchanging technical information.

Around one-half of the states have patterned new water pollution control legislation, or amendments of existing legislation, on a model act drafted in 1950 by the Public Health Service. More than 40 states have laws of some kind to protect streams from industrial pollution. The federal government, through the Public Health Service, conducts research, provides technical assistance, and undertakes limited enforcement activities.

President Eisenhower, in a special health message to Congress on Jan. 31, urged that Congress "provide greater assistance to the states . . . for pollution control programs." Noting that intensified research was needed, the President asked that the present Water Pollution Control Act, due to expire June 30, 1956, be extended and strengthened. An administration bill, passed by the Senate on June 17 but still to be acted on by the House, authorizes grants of $2 million a year up to June 30, 1960, to assist states and interstate agencies in pollution-control and prevention measures. The present Water Pollution Control Act has provided for annual grants aggregating $1 million.

Effort to Swell Supply by Artificial Rain-Making

Recent intensive study of the possibilities of alleviating water shortages by artificial rain-making, or by conversion

[18] Leonard B. Dworsky (of Division of Water Pollution Control, U. S. Public Health Service), "Industry's Concern in Pollution Abatement and Water Conservation Measures," *Public Health Reports*, January 1954, p. 43.

of salt water into fresh water, has yielded hopeful results. So-called cloud seeding, to bring on precipitation and replenish water supplies at the right places in the right seasons, has been successful in certain instances. Many prominent meteorologists maintain, however, that not enough significant information has become available to prove or disprove the efficacy of weather modification.[19] Considerable debate has taken place over whether certain rainfall has been due to seeding of clouds with dry ice or other substances or to natural phenomena. In the meantime, commercial cloud seeding has become big business, and rain-making operations have been undertaken in almost every state.

The President's Advisory Committee on Weather Control recently announced that it planned to hold extensive field tests of commercial cloud-seeding techniques next autumn at Mt. Washington in New Hampshire.[20] The Mt. Washington experiments will be concerned in particular with the controversial theory of over-seeding, a practice that some meteorologists think actually may prevent rain.[21]

Accelerated Research on Conversion of Salt Water

Although no inexpensive process for converting sea and other saline water to fresh water has been perfected, recent studies have shown encouraging progress. The Saline Water Act of 1952 launched a five-year Interior Department research program, for which Congress authorized total appropriations of $2 million. Legislation to extend the program to an overall period of 13 years, and at the same time expedite research by increasing the appropriation authorization to a total of $10 million, was sent to the White House on June 21.[22]

David S. Jenkins, director of the research program, told a House Interior subcommittee on Feb. 16 that "It now appears that in time conversion of both brackish and sea

[19] Recently announced results of "Project Scud," an experiment conducted for the Office of Naval Research by Jerome Spar of New York University, included no evidence to indicate that seeding was effective in making, breaking, or modifying storms over extensive areas; however, the possibility of local effects was not ruled out. The project involved seeding by planes and ground generators, for several months in 1953 and 1954, over an area stretching from Florida to Massachusetts.

[20] The committee, established by Congress in 1953, is to submit its report by June 30, 1956.

[21] For further discussion of rain-making, see "Weather Modification," *E.R.R.*, Vol. II 1953, pp. 729-745.

[22] The House, which initially voted a $6 million authorization, accepted a Senate boost to $10 million. Whereas only $400,000 a year was available under the original program (and actually appropriated for fiscal 1956), the increased authorization will permit appropriation of twice that sum in each of the ten years remaining in the 13-year period. Sen. Case (R-S.D.) told a Senate Interior subcommittee at hearings Apr. 19: "This is one bill that has no politics in it, no geography in it, no discrimination in it . . . It is a bill of multiple benefits to all our people."

water will be feasible." Jenkins reported that 24 research contracts had resulted in development of seven or eight very promising processes. He said that cost goals of $100 to $125 an acre-foot for saline water converted for municipal use and of $40 for irrigation water, though not yet realized, were being approached. Such figures contrasted with original estimates of $400 to $500 an acre-foot for converting sea water, with its high salt content.[23]

Because experiments have shown that no single process is capable of providing fresh water for all purposes at all locations, several different methods are under investigation. Among the more outstanding processes are the electric membrane, vapor compression distillation, solar distillation, critical pressure, osmotic device, solvent extraction, and freezing methods. Jenkins told a Senate Interior subcommittee on Apr. 19 that field testing of an electric membrane process developed by Ionics, Inc., of Boston, was under way in Arizona and South Dakota. Pilot plant testing at a seashore location of a distillation still developed by the Badger Manufacturing Co., also of Boston, is expected next year. Jenkins said the possibilities of converting salt water "at a price which might be afforded by municipal or individual users have been greatly enhanced" by development of this still.

The C.I.O. proposed to the Senate subcommittee on Apr. 19 that the Atomic Energy Commission build experimental power reactors in Southern California and Texas "to supply the power necessary for further development of the saline water program." The Interior Department maintains liaison with the A.E.C. but, according to the third annual report on the saline water conversion program, "Direct use of nuclear fission for separation of salt from water is not foreseen at this time." Sen. Anderson (D-N.M.), chairman of the Joint Atomic Energy Committee and of the irrigation and reclamation subcommittee of the Senate Interior Committee, has indicated that the saline conversion program, on the contrary, might contribute to the development of atomic energy by helping to assure availability of the large amounts of water needed in atomic processes.

[23] "Until recently, in a few quarters, it was thought that it might soon be possible to convert ocean water to fresh water and convey it to almost any place where additional water was needed, all at an economical cost. Unfortunately, it is not that simple . . . It appears that conversion of ocean water to fresh water may be practicable in certain coastal areas where existing sources of fresh water are inadequate . . . For areas more than about 100 miles or so inland, however, it is probable that existing saline surface and ground water will be a more promising source of additional water supply." — S. K. Love (U.S. Geological Survey), paper presented at 15th annual water conference, Engineers' Society of Western Pennsylvania, Pittsburgh, Oct. 18, 1954.

Public Policy on Use of Water Resources

PUBLIC POLICY on the use of available water resources is likely to become a larger problem in the future than the methods of conserving or increasing water supplies. Industrial and non-industrial uses of water are usually competitive. Conflicts between irrigation and industry, between navigation and wildlife conservation, between power and fishing are bound to grow.

Proposals to Curb Use of Water for Irrigation

Proposals have been multiplying to cut down the use of water for irrigation in order to increase the volume available for other purposes. Louis Koenig of the Southwest Research Institute suggested at an International Arid Lands Symposium at Albuquerque on Apr. 28 that arid lands might better be used for industrial than for agricultural purposes. The Materials Policy Commission report three years ago spoke of the increasing need "for weighing the economic justification for irrigation against that of industrial use of the same water." It urged a comparison of the "alternate public and private costs with public and private benefits for a given outlay." "In some situations," the report concluded, "it may be more advantageous to the area and to the nation to provide less water for irrigation and more for industry." [24]

In a paper prepared for the commission, Jack R. Barnes, noted hydrologist, wrote that, if conflicts in water use developed in the West as a result of growing industrial and municipal needs, "a reduction of irrigated acreage in some areas . . . would be wise."

> Relative to many other uses, irrigation is a very uneconomic user of water . . . [In 1947, for example] manufacturing produced 50 times as many dollars of products with the same amount of water as did irrigation. Furthermore, the consumptive use of water by irrigation was 5 to 10 times as great as for manufacturing. If the water needs of western cities and industries become more urgent, a great part of the crops now irrigated could be produced from lands in the East reclaimed by clearing and draining in areas of adequate rainfall.[25]

[24] The President's Materials Policy Commission, *Resources for the Future*, Vol. I (June 1952), pp. 55, 54.

[25] *Ibid.*, Vol. V (June 1952), p. 86. Arthur M. Piper of the Geological Survey has asserted, however, that the solution to the problem of competition for water "obviously is more involved than that implied by the President's Materials Policy Commission." — "The Nation-Wide Water Situation," in House Interior and Insular Affairs Committee, *op. cit.*, p. 6.

On the other hand, R. J. Tipton, a water and engineering expert, maintained before a discussion group at the Mid-Century Conference on Resources for the Future, in December 1953, that "the use of water for irrigation is basic." Pointing out that "Food and fibers cannot be produced in the West except by irrigation," Tipton held that irrigation there "as elsewhere, will become increasingly important to the whole country as the population grows." Meanwhile, several members of Congress, notably Sen. Douglas (D-Ill.), have argued that there is little point in irrigating additional crop land when the country already is burdened by food surpluses.

Opposing Doctrines of Water Rights in State Laws

As water demand and competition increase, the laws that regulate water use may have to be re-examined and amended.[26] Different sections of the country, for example, follow diametrically opposed doctrines of water rights. Under the doctrine of *riparian rights* the owner of land adjacent to a stream is entitled to use the natural flow, undiminished in quantity and unchanged in quality, and the next downstream owner has the same right. A riparian right is not lost by non-use. Under the doctrine of *prior appropriation* a "first come, first served" basis prevails, and the first user has a right to divert or consume the entire flow of a stream. An appropriative right, however, generally is forfeited if the water is not used. The riparian rights doctrine has been accepted in the East and the prior appropriation doctrine in the West, but the eastern states are turning more and more to laws embodying the latter principle.

Need for National Coordination of Water Programs

Conflict and competition in water use underline the need for a national water policy that will make fair and effective provisions for the respective interests. Because Congress has not adopted such a policy, the federal agencies concerned with water development operate under different policies to accomplish different objectives. The conflict between the irrigation interest of the Bureau of Reclamation and the navigation and flood control interests of the Corps of Engineers is the most frequently cited case in point, but the

[26] "Water law is bound to be increasingly important in the future as our water demands increase." — C. L. McGuinness, *Water Law With Special Reference to Ground Water* (Geological Survey Circular 117, June 1951), p. 2.

Hoover Commission listed 25 principal federal agencies with "functions relating to water and its use or control."

The federal government has been criticized for its failure — for the most part — to coordinate the varied programs of water development. The Materials Policy Commission observed that federal water policies had evolved over a century "with little thought to overall requirements in terms of organization, consistent reimbursement, and changing pattern of demand and use."

Experts point out that the huge task of conserving and developing water resources offers plenty of work for all levels of government and private enterprise, but national coordination is vital. Until a national water policy is adopted, however, the states are handicapped in fashioning their own programs. A working committee of the first National Watershed Congress, at a meeting held in Washington last December, said that without a national policy it would be "increasingly difficult, if not impossible, to expect anything approaching consistency and compatibility in the water and watershed laws of the . . . states."

Advocacy of Multiple-Purpose Water Development

Even in the absence of a national water policy, there has been considerable acceptance of the multiple-purpose concept of water resources development. Nearly five years ago President Truman's Water Resources Policy Commission noted increasing recognition that "comprehensive development of an entire river system for many purposes" was the best means of achieving public objectives.[27] Multiple-purpose programs can provide not only for farm, industrial, and municipal water needs; they can yield also such benefits as erosion control, stream stabilization, flood control, power development, and improved recreational facilities.

One strong argument for basin-wide, multi-purpose development is what Edward A. Ackerman, formerly assistant general manager of the Tennessee Valley Authority, has referred to as the "compartmentalizing of our water resources." Speaking before the North American Wildlife Conference at Montreal on Mar. 14, Ackerman directed attention to the "distinct incompatibility" between the administrative system of the United States and its physical geography. "We have divided our area into 48 states," he said,

[27] The President's Water Resources Policy Commission, *A Water Policy for the American People* (1950), p. 5.

"but there are only a relatively few major river basins and, therefore, [few] major sources of water supply." Ackerman concluded that still broader concepts and practices in multiple-purpose planning were needed.

President Truman's Water Resources Policy Commission recommended a unified policy and unified responsibility in the planning of multiple-purpose, basin-wide developments. The commission urged enactment of a "single national water resources policy law." Federal agencies were to submit new proposals "only in the form of basin programs . . . which take into account all relevant purposes in water and land development." A Federal Board of Review, appointed by the President, would oversee the "orderly formulation of national water resources programs." The federal government would aim "to recover a reasonable portion of the benefits accruing from public expenditures for water resources development."[28]

The Hoover Commission, recommending that Congress adopt a national water policy, urged it to bear in mind that "Water resources should be developed to assure their optimum use and their maximum contribution to the national economic growth, strength, and general welfare." The commission added that "Water resources development should be generally undertaken by drainage areas—locally and regionally." It said that federal participation in such development should be limited to projects involving the national interest and projects that, "because of size or complexity or potential multiple purposes or benefits, are beyond the means or the needs of local or private enterprise."

Need for Additional Basic Hydrological Data

If research is to enlarge the available water supply, much additional basic hydrological data must be collected and analyzed. Deficiencies in basic information prevent accurate appraisals and projections. The Materials Policy Commission observed three years ago that knowledge of the supply and use of water was "pitifully inadequate." President Eisenhower noted in his budget message, Jan. 17, 1955, that "Adequate collection and evaluation of basic data on topography, minerals, soils, and water and weather conditions are essential to provide a sound basis for water resources projects."

[28] Under Secretary of Interior Clarence A. Davis, addressing the National Rivers and Harbors Congress on May 31, 1955, proposed also that local beneficiaries should assume a substantial share of the costs.

The Geological Survey has listed the following basic items among "critical needs": Comprehensive inventory of water uses, by volume and area, maintained on a current basis; comprehensive appraisal of the nation's water-yielding capacity; continual determination of water quality; "balance-sheet accounting of all available waters against current and prospective uses."[29] Although much primary information on precipitation, stream flow, and ground water reserves is being collected, more rapid interpretation and publication are needed. With respect to consumption, wide variations in estimates of water use point to the need for additional basic data. Reliable information on industrial uses is considered by some experts to be almost non-existent.[30]

Water authorities believe that the general assumption that there will always be enough water in the future has militated against substantial support for programs for collecting water data. But they point out that small-scale savings in the keeping and analyzing of such vital records may end in large-scale waste in water development projects.

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[29] C. L. McGuinness, *The Water Situation in the United States with Special Reference to Ground Water* (Geological Survey Circular 114, June 1951), pp. 126-127.

[30] The Geological Survey at present is preparing a series of reports on the quantitative and qualitative water requirements of selected industries. During the past three years the Survey has issued evaluation reports on the water potential of 17 metropolitan areas; reports on another 10 or 12 areas are expected within the next two years.